A Housing Energy Management Program Report

Energy
Ontario

MAKING THE MOST OF YOUR FORCED AIR HEATING SYSTEM, RETROFIT DEMONSTRATION PROJECT

(PHASE II)

Funding was provided by the Ministry of Municipal Affairs and Housing through funds provided by the Ministry of Energy, through the Housing Energy Management Program (H.E.M.P.).

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Housing Renovation and Energy Conservation Unit

by

THE HEATING, REGRIGERATING, & AIR CONDITIONING INSTITUTE
OF CANADA (H.R.A.I.)

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EXECUTIVE SUMMARY

The Heating, Refrigerating And Air Conditioning Institute (H.R.A.I.), a National Trade Association for these industries, was commissioned by the Ontario Ministry of Municipal Affairs And Housing, with funds provided by the Ministry Of Energy under the Housing Energy Management Program (HEMP), to undertake the development and testing of a program to reduce the energy consumption of existing houses, with forced air systems, by improving the performance of their heating and distribution systems.

This program resulted in the development of what has become known as the "Total Tune-up". The "Total Tune-up" reduced the energy consumed for space heating in 20 test houses by 17% to 30%.

Each house in the test was evaluated for other retrofit opportunities. Thirteen of the 20 houses offered such opportunities. The owners of these houses were given a list of things that they could do to the heating system to further reduce the energy consumption and the potential savings that might be expected from these improvements. Suggestions provided included setback thermostats, conversion burners, duct work and higher efficiency furnaces. The Ministry offered to pay 2/3 of the costs, up to $500, in financial assistance to each homeowner, to encourage them to participate in this

second phase. Only four of the thirteen agreed to take the suggested retrofit actions and they in turn agreed to supply the energy bills for a further heating season so that the real savings, brought about by the retrofit actions, could be determined.

SUMMARY OF PHASE 1 FINDINGS

HOUSE #	1	2	3
CITY	Woodbridge	Woodbridge	Maple
HOUSE AGE	32	28	23
WATER HTR FUEL	Elect.	Elect.	oil
AIR/HYD	air	air	air
FUEL	oil	oil	oil/heat pump
ADJ. ANTICIPATOR	no	no	no
INPUT RATING	29.90	24.60	oil-30.19
OUTPUT RATING	na	na	H.P.-7.03
NOZEL B.F.	0.75	0.75	0.75
NOZEL AFT.	0.75	0.75	0.75
STACK TEMP.B.F.	285.6	199	393.3
STACK TEMP. AFT.	267.2	190	453.9
% CHANGE	(6.44)	(4.52)	15.41
EFFICIENCY B.F.	74	55	50
EFFICIENCY AFT.	77	73	45
% CHANGE	4.05	32.73	-10.00
BONNET TEMP. B.F.	57.2	65.6	46.1
BONNET TEMP AFT.	57.2	60	42.2
% CHANGE	0.00	(8.54)	(8.46)
BON. TEMP RISE BF	41	42.2	22
BON. TEMP RISE AFT	37	36.1	18.2
BON. KWH BF	22.13	16.90	15.40
BON. KWH AFT	23.02	22.50	13.80
% CHANGE	4.05	33.14	(10.39)
BON. CFM BF	26.04	19.32	33.78
BON.CFM AFT.	30.02	30.07	36.59
% CHANGE	15.30	55.63	8.32
ADJ. FAN SETTING	yes	yes	repl. belt
BLWR CLEANED	no	yes	yes
FILTER	changed	changed	no
CHIMNEY COND.	good	ok	very dirty
kW/degree day before	11.82	7.65	na
kW/degree day after	12	6.26	na
% change	1.00%	-18.11%	na
RECOMMENDATIONS	Plenum heater Gas conv. brnr Duct insul.	Gas furnace	Duct work Repl. fan mtr Re-inst. air/cl

HOUSE #	4	5	6
CITY	Thornhill	Thornhill	Thornhill
HOUSE AGE	30	43	17
WATER HTR FUEL	elect	elect	elect
AIR/HYD	air	air	air
FUEL	elect	gas	elect
ADJ. ANTICIPATOR	no	no	no
INPUT RATING	15	29.9	na
OUTPUT RATING	15	22.7	na
NOZEL B.F.	na	na	na
NOZEL AFT.	na	na	na
STACK TEMP.B.F.	na	124.4	na
STACK TEMP. AFT.	na	132.2	na
% CHANGE	ERR	6.27	ERR
EFFICIENCY B.F.	100	75.7	100
EFFICIENCY AFT.	100	78.5	100
% CHANGE	0.00	3.70	0.00
BONNET TEMP. B.F.	65.6	48.9	82.2
BONNET TEMP AFT.	65.6	54.4	50.6
% CHANGE	0.00	11.25	(38.44)
BON. TEMP RISE BF	44.4	30.5	63.3
BON. TEMP RISE AFT	44.4	36.1	30.3
BON. KWH BF	15.00	22.60	na
BON. KWH AFT	15.00	23.50	na
% CHANGE	0.00	3.98	ERR
BON. CFM BF	16.30	35.75	na
BON.CFM AFT.	16.30	31.41	na
% CHANGE	0.00	(12.15)	ERR
ADJ. FAN SETTING	needs swtch	yes	no
BLWR CLEANED	na	no	no
FILTER	cleaned	no	cleaned
CHIMNEY COND.	na	ok	na
kW/degree day before	3.5	na	5.4
kW/degree day after	2.2	na	4.54
% change	-37.07%	na	-15.93%
RECOMMENDATIONS	None	Duct tape	None

HOUSE #	7	8	9
CITY	MAPLE	MAPLE	Thornhill
HOUSE AGE	26	23	30
WATER HTR FUEL	gas	gas	elect
AIR/HYD	air	air	air
FUEL	gas	gas	oil
ADJ. ANTICIPATOR	no	no	no
INPUT RATING	30.8	32.8	na
OUTPUT RATING	24.2	26.2	na
NOZEL B.F.	na	na	1.00
NOZEL AFT.	na	na	1.00
STACK TEMP.B.F.	214	115.6	283.3
STACK TEMP. AFT.	159.5	110	253.3
% CHANGE	(25.47)	(4.84)	(10.59)
EFFICIENCY B.F.	76	72.3	69.6
EFFICIENCY AFT.	77	79.4	74.5
% CHANGE	1.32	9.82	7.04
BONNET TEMP. B.F.	76.7	65.6	73.9
BONNET TEMP AFT.	71.1	62.8	79.4
% CHANGE	(7.30)	(4.27)	7.44
BON. TEMP RISE BF	55.6	41.25	54.4
BON. TEMP RISE AFT	46.2	38.5	55.6
BON. KWH BF	23.39	23.73	28.60
BON. KWH AFT	23.70	26.13	30.60
% CHANGE	1.33	10.11	6.99
BON. CFM BF	20.30	27.76	25.37
BON.CFM AFT.	24.75	32.75	26.56
% CHANGE	21.94	17.98	4.68
ADJ. FAN SETTING	yes	yes	faulty sw.
BLWR CLEANED	no	no	cleaned
FILTER	no	cleaned	ok
CHIMNEY COND.	ok	soot	much soot
kW/degree day before	7.14	9.23	6.1
kW/degree day after	7.18	6.73	5.32
% change	0.60%	-27.10%	-12.79%
RECOMMENDATIONS	None	None	duct work duct insul. setback therm new gas furn.

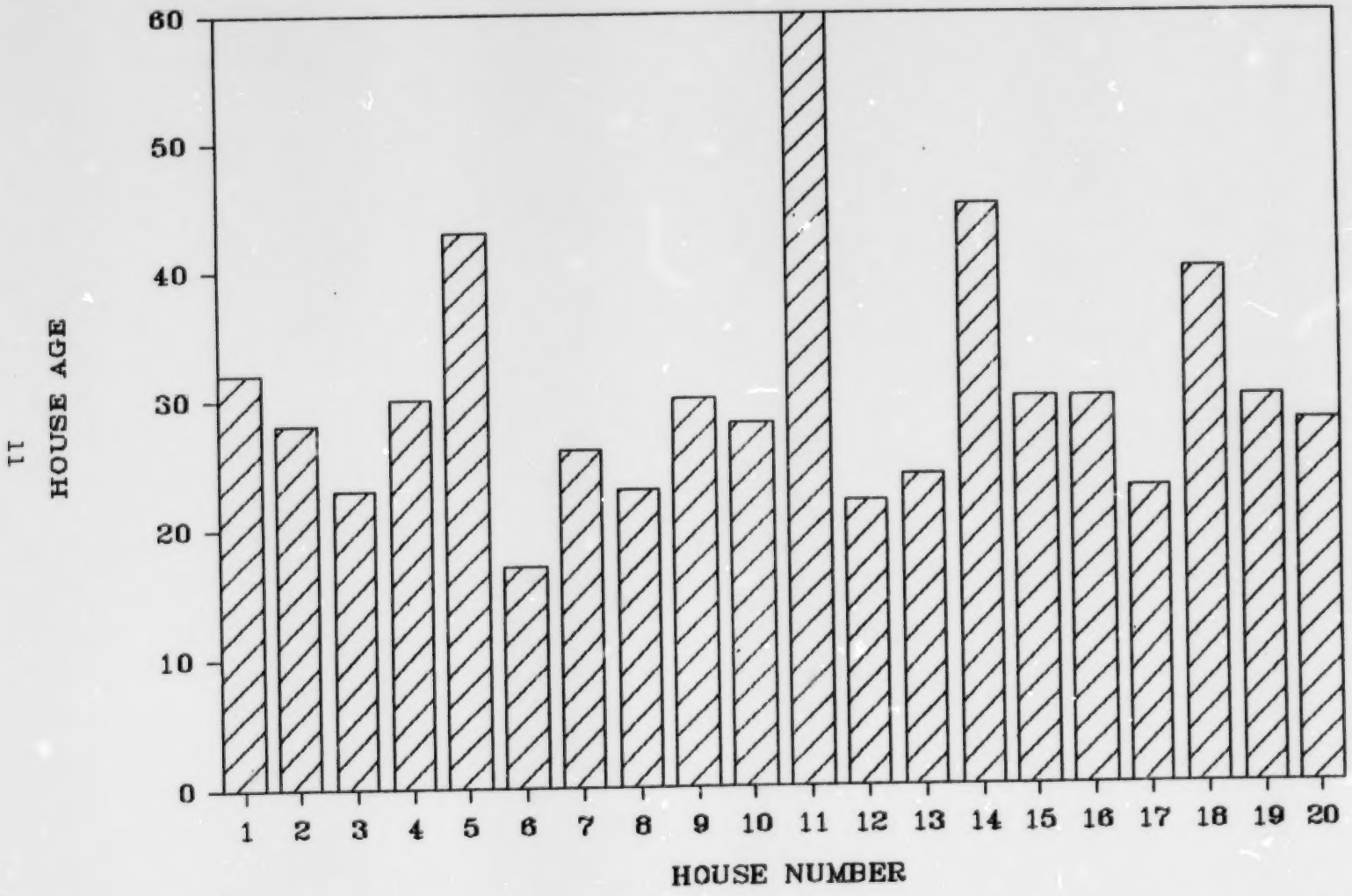
HOUSE #	10	11	12
CITY	WOODBRIDGE	KLEINBERG	MAPLE
HOUSE AGE	28	60	22
WATER HTR FUEL	elect	elect	gas
AIR/HYD	air	air	air
FUEL	elect	gas	gas
ADJ. ANTICIPATOR	no	yes	no
INPUT RATING	20	130000	29.3
OUTPUT RATING	20	104000	23.4
NOZEL B.F.	na	na	na
NOZEL AFT.	na	na	na
STACK TEMP.B.F.	na	151.1	135.6
STACK TEMP. AFT.	na	140.6	126.7
% CHANGE	ERR	(6.95)	(6.56)
EFFICIENCY B.F.	100	76	74.3
EFFICIENCY AFT.	100	77.6	76
% CHANGE	0.00	2.11	2.29
BONNET TEMP. B.F.	62.8	60	76.7
BONNET TEMP AFT.	63.3	57.2	72.5
% CHANGE	0.80	(4.67)	(5.48)
BON. TEMP RISE BF	35	38.5	50
BON. TEMP RISE AFT	41.1	33	38.8
BON. KWH BF	20.00	29.00	20.90
BON. KWH AFT	20.00	29.60	21.40
% CHANGE	0.00	2.07	2.39
BON. CFM BF	27.57	36.34	20.17
BON.CFM AFT.	23.48	43.28	26.61
% CHANGE	(14.84)	19.08	31.95
ADJ. FAN SETTING	not adjust.	yes	yes
BLWR CLEANED	no	no	no
FILTER	no	cleaned	changed
CHIMNEY COND.	na	ok	ok
kW/degree day before	5.58	13.43	7.52
kW/degree day after	3.39	10.19	9.31
% change	-39.26%	-24.16%	23.80%
RECOMMENDATIONS	none	duct work	comb. air

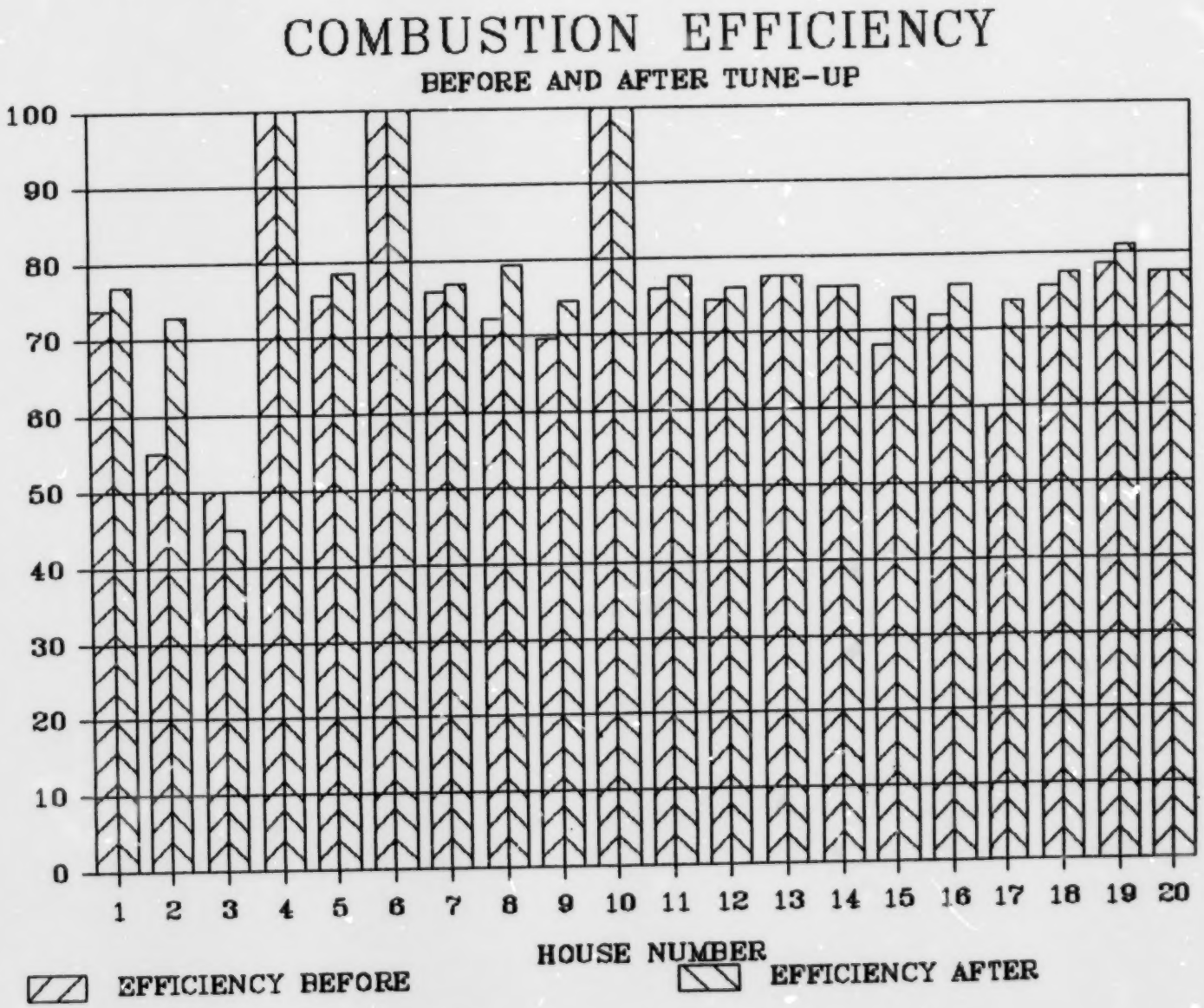
HOUSE #	13	14	15
CITY	MAPLE	WOODBRIDGE	THORNHILL
HOUSE AGE	24	45	30
WATER HTR FUEL	gas	elect	gas
AIR/HYD	air	air	air
FUEL	gas	oil	oil
ADJ. ANTICIPATOR	no	no	no
INPUT RATING	30.8	26.7	25.5
OUTPUT RATING	24.6	na	na
NOZEL B.F.	na	0.85	0.75
NOZEL AFT.	na	0.85	0.75
STACK TEMP.B.F.	165.6	278	303.9
STACK TEMP. AFT.	165.6	278	300
% CHANGE	0.00	0.00	(1.28)
EFFICIENCY B.F.	77.5	76	68.1
EFFICIENCY AFT.	77.5	76	74.3
% CHANGE	0.00	0.00	9.10
BONNET TEMP. B.F.	57.2	61.1	112.8
BONNET TEMP AFT.	60	76.7	121.1
% CHANGE	4.90	25.53	7.36
BON. TEMP RISE BF	39.1	38.5	97.1
BON. TEMP RISE AFT	39.1	47.9	103.8
BON. KWH BF	23.85	25.80	21.00
BON. KWH AFT	23.85	25.80	22.86
% CHANGE	0.00	0.00	8.86
BON. CFM BF	29.43	32.33	10.44
BON.CFM AFT.	29.43	25.99	10.63
% CHANGE	0.00	(19.62)	1.83
ADJ. FAN SETTING	no	yes	yes
BLWR CLEANED	no	no	yes
FILTER	clean	clean	no
CHIMNEY COND.	good	ok	dirty
kW/degree day before	7.19	5.18	8.62
kW/degree day after	5	3.16	6.42
% change	-30.46%	-38.98%	-25.52%
RECOMMENDATIONS	none	plen. htr gas furn.	owners gas furn.

HOUSE #	16	17	18
CITY	THORNHILL	THORNHILL	THORNHILL
HOUSE AGE	30	23	40
WATER HTR FUEL	elect	elect	oil
AIR/HYD	air	air	air
FUEL	oil	oil	oil
ADJ. ANTICIPATOR	no	no	no
INPUT RATING	na	32.6	36
OUTPUT RATING	na	na	na
NOZEL B.F.	0.75	0.85	1.25
NOZEL AFT.	0.75	0.85	1.10
STACK TEMP.B.F.	332.2	299	310
STACK TEMP. AFT.	310	284	297.8
% CHANGE	(6.68)	(5.02)	(3.94)
EFFICIENCY B.F.	72	60	75.7
EFFICIENCY AFT.	76	73.8	77.4
% CHANGE	5.56	23.00	2.25
BONNET TEMP. B.F.	76.7	62.8	73.9
BONNET TEMP AFT.	71.1	72.2	77.4
% CHANGE	(7.30)	14.97	4.74
BON. TEMP RISE BF	53.9	41.3	41.6
BON. TEMP RISE AFT	46.2	47.9	44.4
BON. KWH BF	22.20	20.90	38.80
BON. KWH AFT	23.40	25.70	24.90
% CHANGE	5.41	22.97	(35.82)
BON. CFM BF	19.87	24.42	45.00
BON.CFM AFT.	24.44	25.89	27.06
% CHANGE	22.97	6.02	(39.87)
ADJ. FAN SETTING	yes	no	yes
BLWR CLEANED	ok	yes	yes
FILTER	cleaned	ok	ok
CHIMNEY COND.	ok	dirty	dirty
kW/degree day before	9.42	7.71	16.15
kW/degree day after	7.65	7.09	10.73
% change	-18.79%	-8.04%	-33.56%
RECOMMENDATIONS	ret. air plen. htr	gas furn.	gas conv brnr plen. htr

HOUSE #	19	20
CITY	MAPLE	MAPLE
HOUSE AGE	30	28
WATER HTR FUEL	elect	elect
AIR/HYD	air	air
FUEL	oil	gas
ADJ. ANTICIPATOR	no	no
INPUT RATING	34.3	24
OUTPUT RATING	na	21.3
NOZEL B.F.	0.75	na
NOZEL AFT.	0.75	na
STACK TEMP.B.F.	245	150.4
STACK TEMP. AFT.	210.6	149.3
% CHANGE	(14.04)	
EFFICIENCY B.F.	78.6	77.5
EFFICIENCY AFT.	81	77.5
% CHANGE	3.05	
BONNET TEMP. B.F.	79.4	62.8
BONNET TEMP AFT.	82.2	62.8
% CHANGE	3.53	
BON. TEMP RISE BF	51.1	37
BON. TEMP RISE AFT	57.7	37
BON. KWH BF	24.13	18.6
BON. KWH AFT	27.24	18.6
% CHANGE	12.89	0
BON. CFM BF	22.78	
BON.CFM AFT.	22.78	
% CHANGE	(0.02)	
ADJ. FAN SETTING	no	no
BLWR CLEANED	yes	no
FILTER	ok	ok
CHIMNEY COND.	ok	ok
kW/degree day before	5.66	11.7
kW/degree day after	5.42	6.24
% change	-4.27%	-46.71%
RECOMMENDATIONS	duct work plen. htr s/b therm	none

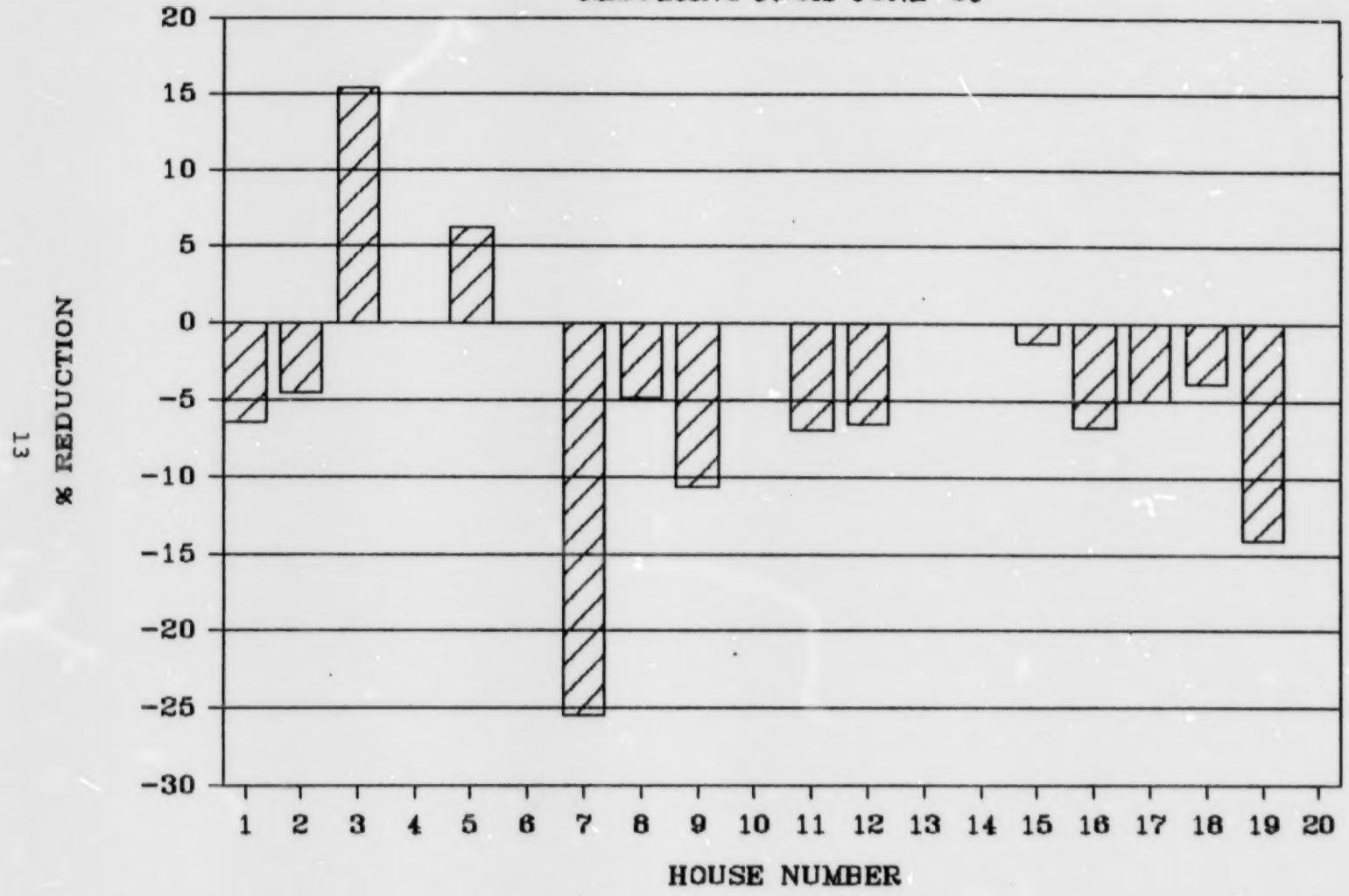
HOUSE AGE


60
50
40
30
20
10
0
HOUSE AGE
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
HOUSE NUMBER


COMBUSTION EFFICIENCY
BEFORE AND AFTER TUNE-UP
EFFICIENCY %
100
90
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
HOUSE NUMBER
EFFICIENCY BEFORE
EFFICIENCY AFTER

CHANGES IN NET STACK TEMPERATURES

RESULTING FROM TUNE-UP



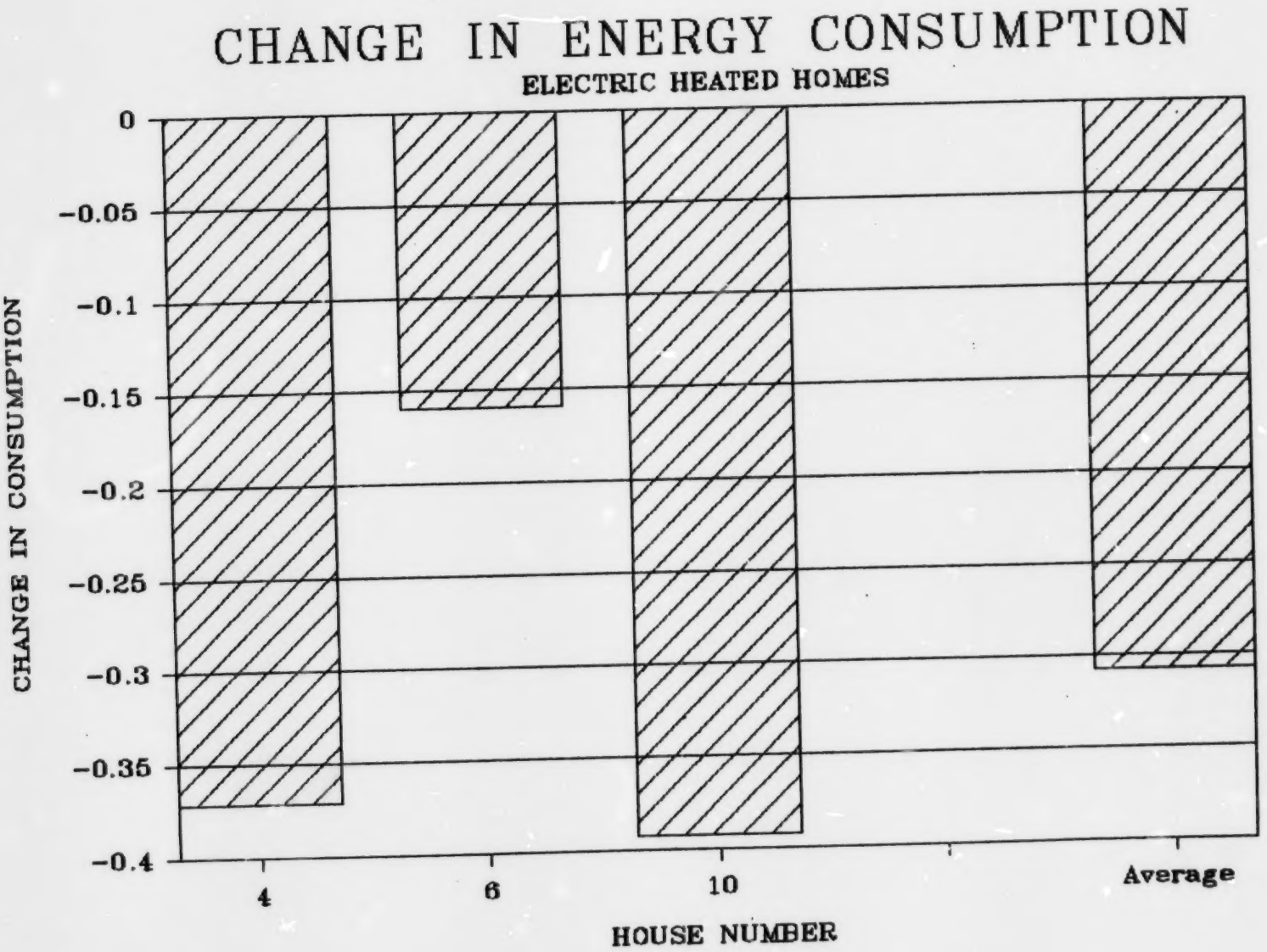
MONITORING RESULTS

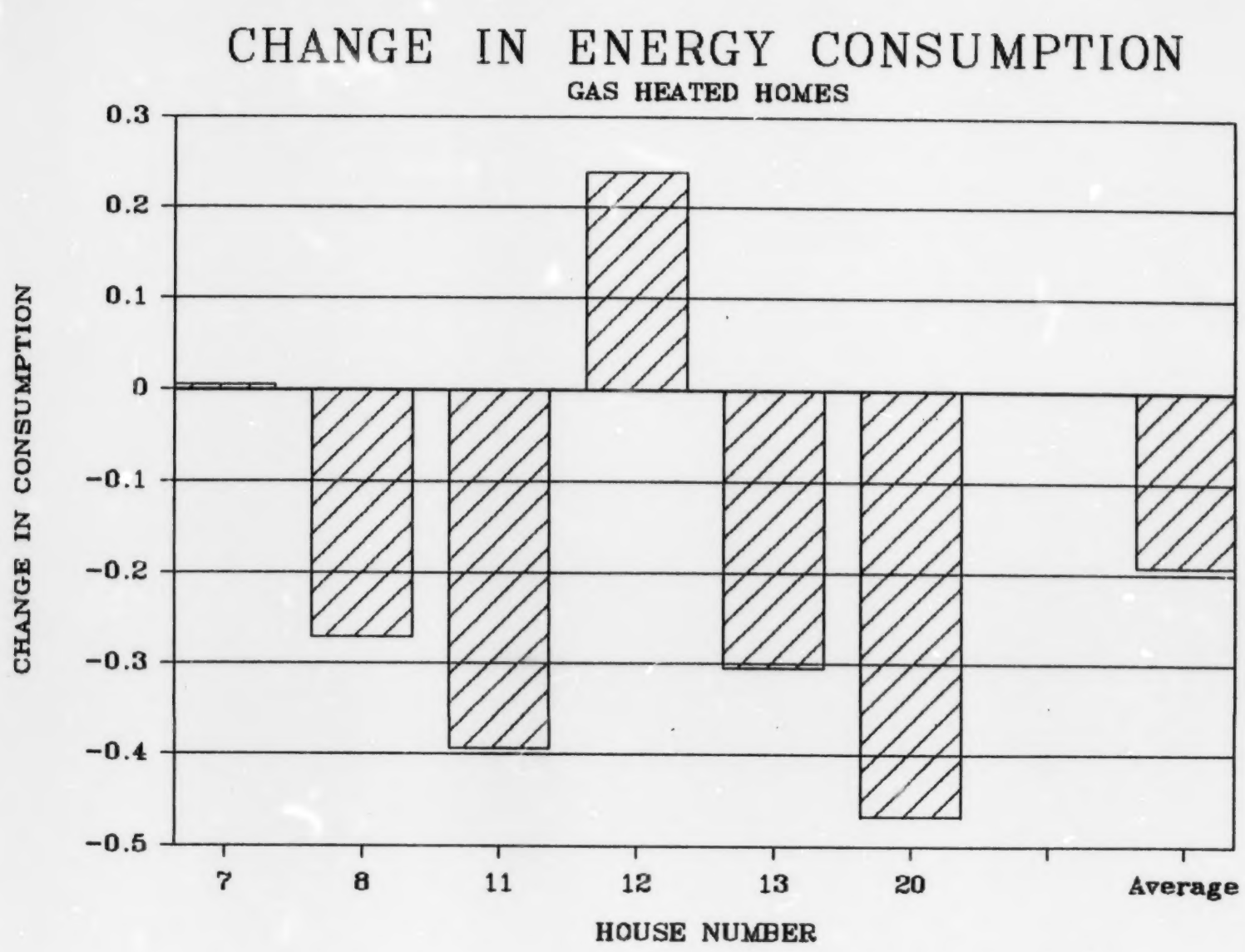
The energy consumption for space heating in the 20 test houses was monitored during the 1983/1984 heating season to determine the effectiveness of the tune-ups. Though the results for each house varied somewhat from those obtained during the short monitoring period, immediatly after the tune-ups were completed, the average change in consumption did not.

The average reduction in energy consummed for space heating in the electrically heated homes was 30.8%. This reduction was the result of repairs made to long neglected furnaces and distribution systems. The houses heated with gas showed an average reduction in consumption of 19.2%. This reduction was caused by a combination of combustion efficiency and distribution system improvements. One house showed a consumption increase of 23.8%, however, the house was occupied by new owners who probably had different living habits, during the 1983/1984 heating season. The results of the monitoring of this house were not included in the averages. Oil consumption, in those houses heated with oil, was reduced by an average of 17.7% through improvements in combustion efficiency and the distribution system. Surprisingly, electrically heated houses had the greatest reduction in energy consumption and oil heated houses the smallest----the opposite of what might have been expected. The reason probably

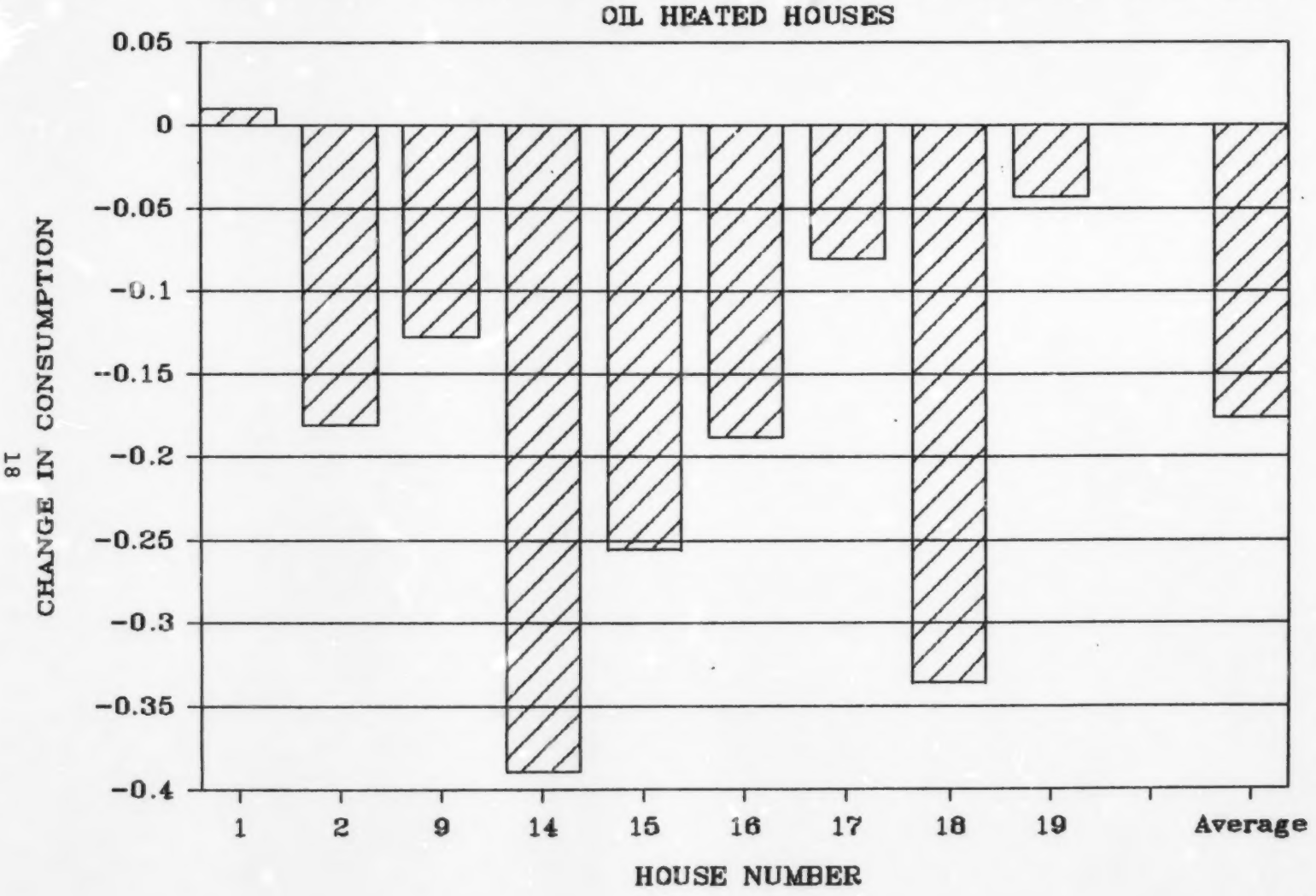
relates to the normal service intervals of each of these system types. Most oil furnaces are tuned every year, gas furnaces occasionally, and electric furnaces seldom, if ever.

The following tables and charts show the changes in energy consumption resulting from the tune-ups in more detail.


CHANGE IN ENERGY CONSUMPTION
ELECTRIC HEATED HOMES
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4
CHANGE IN CONSUMPTION
4
6
10
Average
HOUSE NUMBER


CHANGE IN ENERGY CONSUMPTION
GAS HEATED HOMES
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
CHANGE IN CONSUMPTION
7
8
11
12
13
20
Average
HOUSE NUMBER

REDUCTION IN ENERGY CONSUMPTION



CHANGES IN ENERGY CONSUMPTION DURING THE HEATING SEASON

FOLLOWING THE TUNE-UPS

ELECTRIC HEATED HOUSES

House #	Change in Consumption
4	-37.17%
6	-15.93%
10	-39.26%
Average	-30.79%

GAS HEATED HOUSES

House #	Change in Consumption	
7	0.60%	
8	-27.10%	
11	-39.26%	
12	23.80%	New owners since tune-up.
13	-30.46%	
20	-46.71%	
Average	-19.24%	House 12 not included

OIL HEATED HOUSES

House #	Change in Consumption
1	1.00%
2	-18.11%
9	-12.79%
14	-38.98%
15	-25.52%
16	-18.79%
17	-8.04%
18	-33.56%
19	-4.27%
Average	-17.67%

IMPROVED

CHECKLISTS

TOTAL TUNE-UP
ELECTRIC FORCED-AIR SYSTEM TUNE-UP
CHECK LIST

Homeowner's Name _____

Address _____ W/O# _____

Phone: Res. _____ Bus. _____ Date of Visit _____

/By _____ Time Arrived _____ Time Out _____

Thermostat A Location OK ( ) Poor ( )
B Type _____

Check Anticipator & Adjust If Necessary. Adjusted? Yes ( ) No ( )

Comments _____

Brief Shell Check Age Of House _____ Fireplace? Yes ( ) No ( )
Damper? Yes ( ) No ( )

Windows – Type _____ Open? _____ Closed? _____

Doors – _____ Insulation Levels? _____

Brief Distribution System Check

Check Outlets and return airs – Sufficient? Yes ( ) No ( )

Comments _____

Visual Check of Distribution System Okay ( ) Poor ( )

Note Dificiencies _____

Homeowner Comfort Problems _____

_____

A/C System Present? Yes ( ) No ( ) Humidifier? Type? _____

Furnace Make _____ Model _____ Rating _____

Check Electrical Elements And Sequencers. Comments? _____

_____

Check fan switch setting and set to 95°F OFF & 120°F ON if necessary.
What was the original fan setting? _____ON _____OFF

Turn-up Thermostat.

Check Lists Available From:

HEATING, REFRIGERATING AND AIR CONDITIONING INSTITUTE OF CANADA
5468 DUNDAS ST. W., SUITE 226, ISLINGTON, ONTARIO M9B 6E3 (416) 239-8191

Distribution System

Fan set for contin. run? Yes ( ) No ( ) 2 Speed mot. Yes ( ) No ( )

Bonnett Temperature _____ Temperature Rise _____ System CFM _____

Inspect Blower Assembly. Clean ( ) Moderate ( ) Dirty ( )

Clean, if necessary and indicate. Cleaned ( )

Check and adjust fan belt and pulley and indicate corrections– –

_____

Change or clean filter if necessaryand indicate _____

If possible balance to satisfy customer complaints, if any.

Comments – _____

_____

Tape any leaky duct connections and indicate. _____
If basement is too warm, close down some of the outlets

New bonnet temperature _____ Temperature Rise _____ System CFM _____

Improvement in distribution system CFM _____ % ?

Lower Thermostat to original setting.

Check Limit Switch. OK ( ) Replace ( )

SUGGESTED IMPROVEMENTS

Setback thermostat (?) _____

_____

Heat Pump _____

_____

Duct Work _____

_____

Repairs _____

Other _____

Owners estimated annual space heating cost? $ _____

TOTAL TUNE-UP
GAS FORCED AIR SYSTEM TUNE-UP
CHECK LIST

Homeowner's Name _____

Address _____ W/O# _____

Phone: Res. _____ Bus. _____ Date of Visit _____

/By _____ Time Arrived _____ Time Out _____

Thermostat A Location OK ( ) Poor ( )
B Type _____

Check Anticipator & Adjust If Necessary. Adjusted? Yes ( ) No ( )

Comments _____

Brief Shell Check Age Of House _____ Fireplace? Yes ( ) No ( )
Damper? Yes ( ) No ( )

Windows – Type _____ Open? _____ Closed? _____

Doors – _____ Insulation Levels? _____

Brief Distribution System Check

Check Outlets and return airs – Sufficient? Yes ( ) No ( )

Comments _____

Visual Check of Distribution System Okay ( ) Poor ( )

Note Dificiencies _____

Homeowner Comfort Problems _____

_____

_____ Water heater fuel _____

A/C System? Yes ( ) No ( ) Humidifier? Type? _____

Chimney – Masonry – Tile Lined ( ). Manufactured Type A ( )
No Liner ( ). Type B- _____
Metal Liner ( ). Other _____

State Condition & Recommendations _____

_____

Check Lists Available From:

HEATING, REFRIGERATING AND AIR CONDITIONING INSTITUTE OF CANADA
5468 DUNDAS ST. W., SUITE 226, ISLINGTON, ONTARIO M9B 6E3 (416) 239-8191

Furnace Make? _____ Model _____

Input Rating _____ Output Rating _____

Turn-up Thermostat.

Complete Following Combustion Test

CO_2 ____% Room Temp. _____ Stack Temp. ____ Net Stack _____

Efficiency ____ % Bonnet Temp. _____ Temp. Rise ____ Bonnet BTUH _____ Bonnet CFM ____

Turn Furnace Switch Off

Check fan switch setting and set to 95°F OFF & 120°F ON if necessary.
What was the original fan setting? _____ ON _____ OFF

Set for continuous run? Yes ( ) No ( ) 2 Speed fan Motor? _____

Inspect Blower Assembly. Clean ( ) Moderate ( ) Dirty ( )

Clean if necessary and indicate. Cleaned ( )

Check and adjust fan belt and pulley and indicate corrections – –

_____

Change or clean filter if necessary and indicate

Heat Exchanger Condition – (A) Clean (B) Average (C) Dirty

Clean Heat Exchanger If (B) or (C) Exists. Cleaned _____ Not Required _____

Check Combustion Chamber Condition – Good? _____ Poor? _____ Type _____

Comments _____

Initial Metered Gas Input _____

Metered Input After Adjustment, If Any Adjustment Made _____

Turn on Furnace

If possible balance to satisfy customer complaints, if any.

Comments – _____

Complete Combustion Test Two And Record.

CO_2____ % Room Temp._____ Stack Temp._____ Net Stack Temp._____

Efficiency____ % New Bonnet Temp. _____ Temp. Rise_____

Bonnet BTUH _____ % Efficiency Change After Tune-up____%

New System CFM_____ Improvement ____%

Is there sufficient combustion air? Yes ( ) No ( )

Comments _____

Check Limit Switch. OK ( ) Replace ( )

Check Other Safety Devices _____

Lower Thermostat To Original Setting

OTHER POSSIBLE IMPROVEMENTS TO THIS HEATING SYSTEM

Setback thermostat (?) _____

_____

Duct Work _____

_____

Condensing Gas Furnace _____

_____

Heat Pump _____

_____

Chimney repairs _____

_____

Rapairs (?) _____

_____

Other _____

_____

Home owners estimated annual space heating cost $_____

TOTAL TUNE-UP
OIL FORCED AIR SYSTEM TUNE-UP
CHECK LIST

Homeowner's Name _____

Address _____ W/O# _____

Phone: Res. _____ Bus. _____ Date of Visit _____

/By _____ Time Arrived _____ Time Out _____

Thermostat A Location OK ( ) Poor ( )
B Type _____

Check Anticipator & Adjust If Necessary. Adjusted? Yes ( ) No ( )

Comments _____

Brief Shell Check Age Of House _____ Fireplace? Yes ( ) No ( )
Damper? Yes ( ) No ( )

Windows – Type _____ Open? _____ Closed? _____

Doors – _____ Insulation Levels? _____

Brief Distribution System Check

Check Outlets and return airs – Sufficient? Yes ( ) No ( )

Comments _____

Visual Check of Distribution System Okay ( ) Poor ( )

Note Dificiencies _____

Homeowner Comfort Problems _____

_____

A/C System Present? Yes ( ) No ( ) Humidifier? _____ Type? _____

Chimney – Masonry – Tile Lined ( ). Manufactured Type A ( )
No Liner ( ). Type B- _____
Metal Liner ( ). Other _____

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State Condition & Recommendations _____

_____

Furnace Make _____ Model _____

Burner Make _____ Model _____

Complete Following Combustion Test

COMBUSTION TEST PROCEDURE

Test one is conducted before any work is completed.

Test two is conducted after all tune-up procedures have been completed.

COMBUSTION TEST PROCEDURE & INSPECTION DATA

1)	Flame Ignit.—	Instant	( )	( )	7)	Flue Gas Temp.	( )	( )
		Delayed	( )	( )				
		No Ignition	( )	( )	8)	Basement Air Temperature	( )	( )
2)	Flame Colour (If flame in 2 Colours check both)	Orange	( )	( )	9)	Net Stack Temperature (7–8)	( )	( )
		Yellow	( )	( )				
		White	( )	( )				
		Sparks	( )	( )	10)	Flue Draft in. of W.C.	( )	( )
3)	Flame Shape	Uniform	( )	( )	11)	% C.O.2	( )	( )
		Lop-Sided	( )	( )				
					12)	Smoke Reading #	( )	( )
4)	Flame Impingement	At Bottom	( )	( )				
		At Sides	( )	( )	13)	% Combustion Efficiency	( )	( )
		At Rear	( )	( )				
5)	Soot Deposit	Flue	( )	( )	14)	Oil Pressure (PSI)	( )	( )
		Comb. Chamber	( )	( )				
6)	Over Fire Draft In W.C.		( )	( )	15)	Nozzel-Size	( )	( )
						Type	( )	( )
						Spray Ang.	( )	( )

Bonnet Temperature _____ Temp. Rise _____

Bonnet btuh _____ Bonnet cfm _____

Turn Off Main Switch

Inspect Blower Assembly. Clean ( ) Moderate ( ) Dirty ( )

Clean if necessaryand indicate. Cleaned ( )

Check and adjust fan belt and pulley and indicate corrections – – – –

_____

Change or clean filter if necessary and indicate _____

Heat Exchanger Condition – (A) Clean (B) Average (C) Dirty

Clean Heat Exchanger If (B) or (C) Exists. Cleaned _____ Not Required _____

Check Combustion Chamber Condition – Good?_____ Poor?_____ Type _____

Comments _____

Check fan switch setting and set to 95°F OFF & 120°F ON if necessary.
What was the original fan setting?_____ON_____OFF

Set for continuous run? Yes ( ) No ( ) 2 Speed Fan Motor? _____

Distribution System

If possible balance to satisfy customer complaints, if any.

Comments – _____

_____

Complete Combustion Test Two And Record on page 2.

New Bonnet Temperature _____ Temp. Rise _____

New Bonnet Btuh? _____ % Improvement _____

New Bonnet cfm _____ % Improvement _____

Is there sufficient combustion air? Yes ( ) No ( )

Comments _____

Check Relay Safety Lockout _____ Seconds On?

Check Limit Switch OK ( ) Replace ( )

Lower Thermostat To Original Setting

OTHER POSSIBLE IMPROVEMENTS TO THIS HEATING SYSTEM.

Setback thermostat (?) _____

_____

Flame Retention Head Kit (?) _____

_____

New burner (?) _____

_____

Flue damper (?) _____

Condensing oil furnace (?) _____

_____

Gas conversion burner (?) _____

_____

Chimney cleaning (?) _____

_____

Repairs (?) _____

_____

Plenum Heater (?) _____

_____ Electric Service Entrance_____

Heat Pump (?) _____

_____

New Gas Furnace (?) _____

Is gas available?_____ Does owner object to gas? _____

Other _____

Owners estimated annual space heating cost (?) _____

_____

_____

_____

TOTAL TUNE-UP
GAS/OIL FURNACE TUNE-UP SUMMARY
A REPORT TO THE HOUSEHOLDER

CONGRATULATIONS Your heating system has received a professional tune-up to maximize it's efficiency and reduce your energy bills. Here is a brief summary of the work done and the results.

Homeowner's Name _____ Date _____

Address _____ Phone _____

Thermostat Location Okay Bad Comments _____

_____

Distribution System Checked outlets and Return Air

Sufficient Number? Yes No Comments _____

Visual check of distribution system. Okay ( ) Poor ( )

Any deficiencies _____

Distribution system changes made for comfort improvement –

_____

Blower Assembly – Clean ( ) Moderate ( ) Dirty ( ) Cleaned? Yes No

Fan Belt & Pully – Okay ( ) Adjusted ( )

Taped Leaking Ducts? Yes ( ) No ( )

Furnace _____	**Before Tune-Up**	**After Tune-Up**
Efficiency	_____	_____
Temperature Of Chimney Gases (The Lower, The Better)	_____	_____
Heat Output Of Furnace (Lower Is Okay, If Oil Nozzle Downsized)	_____	_____
Total Air Circulated (Higher is better)	_____	_____

Heat exchanger condition Clean ( ) Moderate ( ) Dirty ( )

Comments _____

Combustion Chamber Comments _____

Chimney Condition and Recommendations _____

Safety Devices OK ( ) Comments _____

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TOTAL TUNE-UP
ELECTRIC FURNACE TUNE-UP SUMMARY
A REPORT TO THE HOUSEHOLDER

CONGRATULATIONS Your heating system has received a professional tune-up to maximize it's efficiency and reduce your energy bills. Here is a brief summary of the work done and the results.

Homeowner's Name _____ Date _____

Address _____ Phone _____

Thermostat Location Okay Bad Comments _____

_____

Distribution System Checked outlets and Return Air

Sufficient Number? Yes No Comments _____

Visual check of **distribution system.** Okay ( ) Poor ( )

Any deficiencies _____

Distribution system changes made for comfort improvement –

_____

Blower Assembly – Clean ( ) Moderate ( ) Dirty ( ) Cleaned? Yes No

Fan Belt & Pully – Okay ( ) Adjusted ( )

Taped Leaking Ducts? Yes ( ) No ( )

Furnace	**Before Tune-Up**	**After Tune-Up**
Furnace Heat Output	_____	_____
Temperature Rise	_____	_____
Total Air Circulated (Higher is better)	_____	_____

Improvement in System Air Volume _____%

Safety Devices OK ( ) Comments _____

Other Comments _____

_____

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RETROFITS

RETROFITS

Thirteen of the houses visited during the Phase 1 tune-ups had potential energy saving retrofit opportunities. Despite the fact that many of those retrofits would have qualified for a COSP Grant and all would have received an incentive of up to $500 through this project, to carry out the retrofits providing they agreed to a further year of monitoring, only four expressed any interest in proceding. Two of the four have actually acted and carried out the recommended retrofits. Both had oil furnaces and qualified for the COSP Grant. One chose to install a Lennox Pulse furnace and the other a conversion gas burner and the insulation of some ducts that ran through an unheated space.

In addition, it was decided to retrofit a defective boiler in the Hydronic pilot project that presented an immediate danger to the owner's health and safety. A new condensing gas fired boiler was installed to not only reduce energy consumption, but to also eliminate the necessity of a long horizontal vent run ---- the major contributor to the premature demise of the defective boiler.

A summary of each recommended retrofit follows, along with an inspection report for those installations that are now complete.

RETROFIT SPECIFICATION SHEET

House 1, Phase 1

(1) Gas Conversion Burner
Quotation should include:
- (A) Heat loss calculation.
- (B) Obtaining of a building permit and inspection.
- (C) Installation should be by a qualified gas fitter.
- (D) Burner heat output should not exceed heat loss calculation by more than 20%.
- (E) Cost of removing oil burner, oil tank, and sealing inlet pipe.
- (F) Gas conversion burner and installation.
- (G) Approved chimney liner.
- (H) Bring gas line into house.
- (I) Providing forms and information for COSP Grant. Installation should be planned, so as to minimize furnace down-time.

(2) Duct Insulation
Quotation should include:
- (A) Cost of insulating trunk ducts in crawl space with R4 and R7 (approx.) insulation.
- (B) Indicate the length of trunk duct that you plan to insulate.

RETROFIT REPORT ON HOUSE #1

An Adams 225 conversion gas burner was installed in a 5 year old ICG oil furnace on May 26, 1984. The oil furnace contained a burner with a .75 nozzle, producing an input rate of 30.76 kw. and an output of 22.77 kw.

The installed conversion burner was adjusted for an input of 28.13 kw. The steady state efficiency was measured at 77% producing an output of 21.66 kw. CO2 was 8% and oxygen was 6.5%. A draft hood and chimney liner were also installed.

A gas water heater was installed at the same time and 9.1 m. of trunk duct, passing through an unheated crawl space, was insulated.

A heat loss calculation was performed (method unknown) indicating a heat loss of 23.7 kw. The output of the oil furnace was only 22.77 kw., yet it provided more than enough heat for the house. This indicates that the method used to calculate the heat loss, probably substantially overstates the actual heat loss.

The installation appeared to be professionaly done and inspected by Consumers Gas Company.

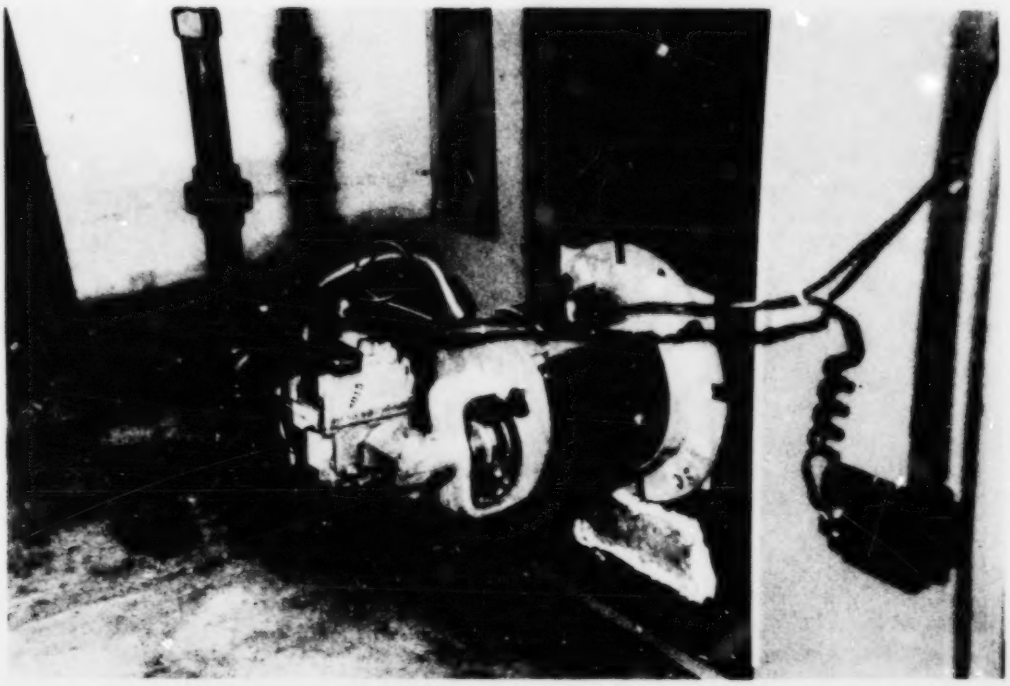
Cost of this installation was as follows:

Burner	$ 750
Chimney Liner	$ 300
Removal Of Oil Tank	$ 75
Insulation Of Trunk Duct	$ 350
Total	$1475

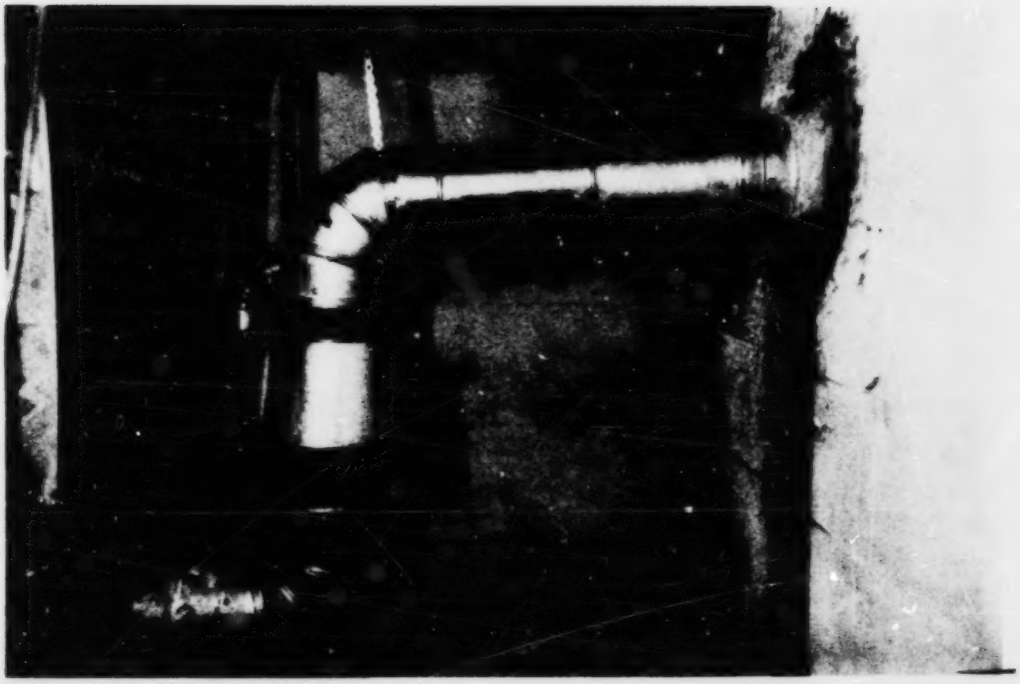
HOUSE #1

FURNACE WITH NEW GAS CONVERSION BURNER

HOUSE #1

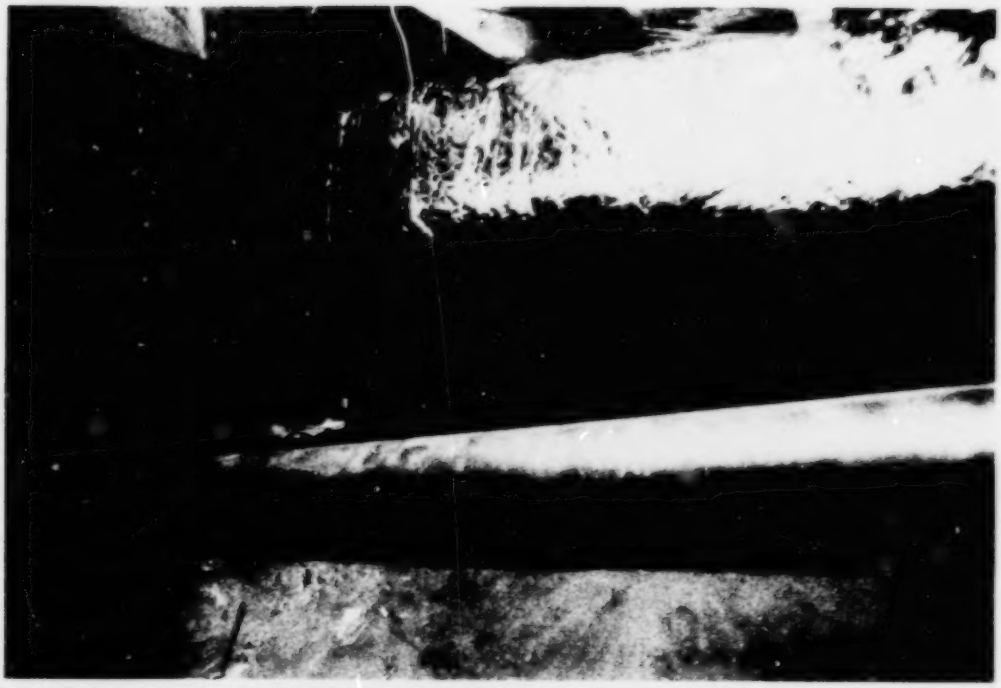


CONVERSION BURNER

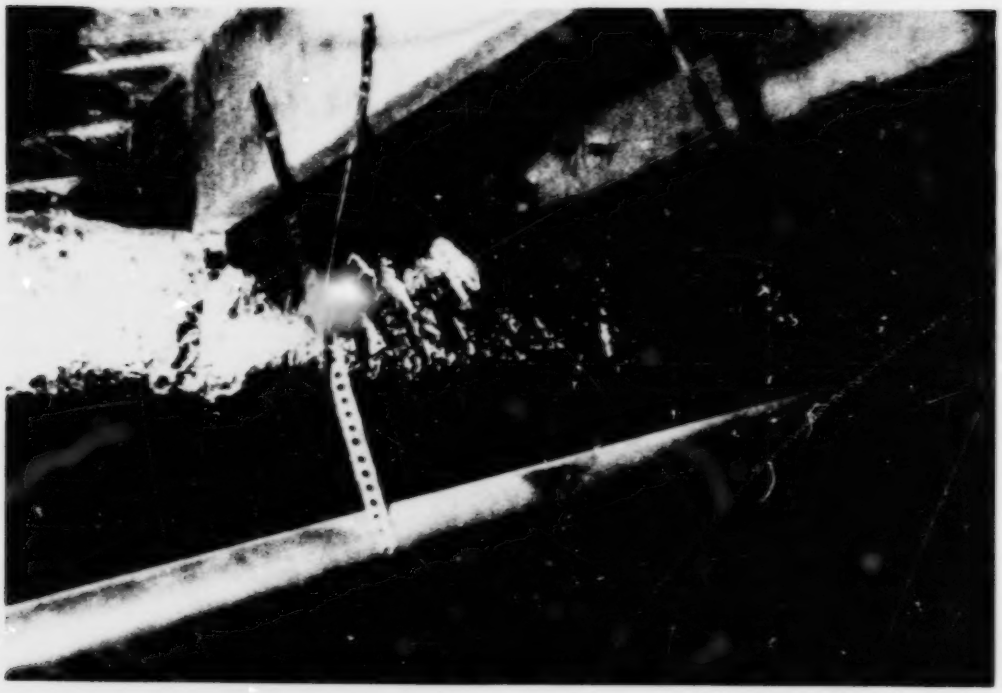


DRAFT HOOD

HOUSE #1



DUCT INSULATED IN UNHEATED CRAWL SPACE



DUCT INSULATED IN UNHEATED CRAWL SPACE

RETROFIT SPECIFICATION SHEET

House 3, Phase 1

(1) **Repair/Replace Blower Motor**
Repair blower motor bearings or replace motor with an identical or more powerful motor. After this repair or replacement, the airflow in the system should be 25% higher than now exists.

(2) **Modify Return Air Plenum For Air Cleaner**
The return air plenum should be tapered to fit the electronic air cleaner to prevent ozone build-up. The air cleaner may be moved up to the top of the return air plenum, if that will better facilitate this work.

(3) **Return Air In Basement**
Provide and instal a return air inlet in the basement T.V. room ceiling or highwall. Inlet size should be at least one joist space.

Quotation should show:
(A) The cost of each of the above separately, as one or all may be undertaken.

RETROFIT SPECIFICATION SHEET

Thornhill. (9)

Mid-Efficiency Gas Furnace (ie. with induced draft and a seasonal efficiency of approximately 75%)

-Complete with a micro-processor-type setback thermostat

OR

High Efficiency Condensing Gas Furnace

-With micro-processor type setback thermostat.
-With exhaust muffler, if pulse type.
-Including condensate pump, if necessary.

The installation and cost of installation shall include:

1. The complete installation of each of the above types by a certified gas fitter.
2. The removal of the present oil furnace, oil line and oil tank and the sealing of the fill pipe.
3. The appropriate arrangements with Consumers Gas to ensure that a gas line is run into the house at a time that coincides with furnace installation.
4. The supply of and completion of all forms required to obtain the COSP grant.
5. Obtaining of a building permit and the related inspection.
6. Sizing the furnace in accordance with a heat loss calculation done by a method recognized in the Ontario Building Code. (ie. HRAI Digest 1980, Manual J 6th. ed.)

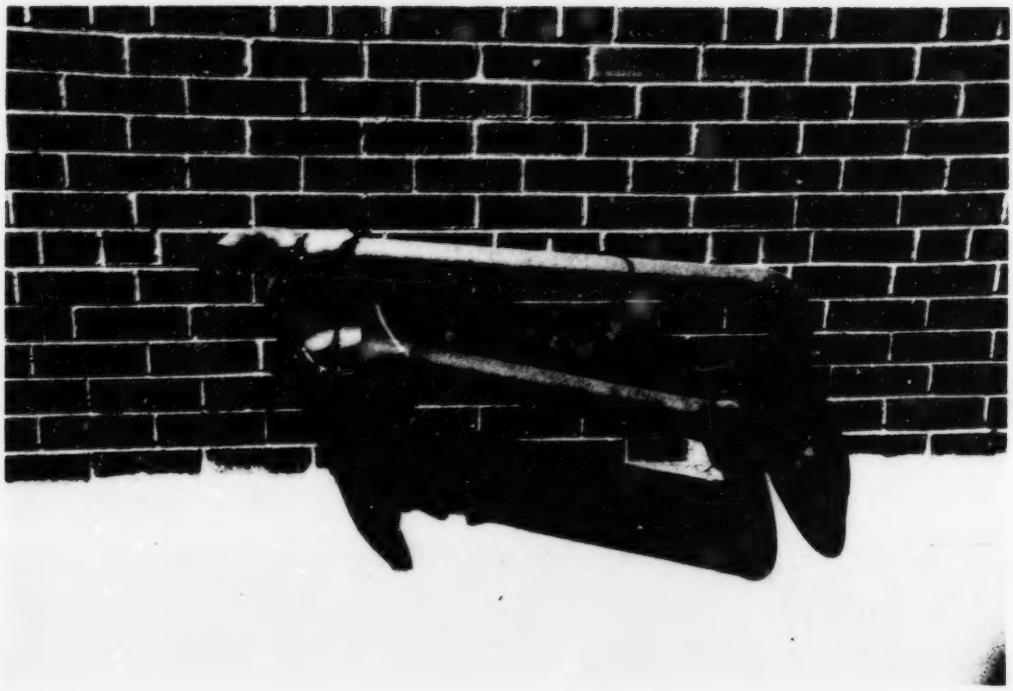
The submitted quotation should indicate the installation date, the down time of the oil furnace when no heat would be available, the payment terms, and the guarantee.

HOUSE 9 RETROFIT REPORT

The owner chose to have a Lennox Pulse furnace installed. The installation was in accordance with the specification sheet provided, except that a heat loss calculation had not been completed. The contractor has since provided this calculation.

When the installation was inspected it was noted that the vent outlet and air intake were not installed in accordance with the manufacturer's instructions. The installing contractor was notified and the situation was rectified. A photograph of the corrected installation follows.

HOUSE #9



CORRECTED VENT & INTAKE INSTALLATION

RETROFIT SPECIFICATION SHEET

Thornhill. (18)

High Efficiency Condensing Gas Furnace

-With digital micro-processor type setback thermostat, suitable for heating and cooling.
-With exhaust muffler, if pulse type.
-Including condensate pump, if necessary.
-With an air handling capacity capable of meeting the requirements of the existing air conditioning system (360 cfm/ton).
-Designed to obtain combustion air directly from outside, because there is a sealed furnace room.

The installation and cost of installation shall include:

1. The complete installation of the above furnace by a certified gas fitter.
2. The removal of the present oil furnace, oil line and oil tank and the sealing of the fill pipe.
3. The appropriate arrangements with Consumers Gas to ensure that a gas line is run into the house at a time that coincides with furnace installation.
4. The supply of and completion of all forms required to obtain the COSP grant.
5. Obtaining of a building permit and the related inspection.
6. Sizing the furnace in accordance with a heat loss calculation done by a method recognized in the Ontario Building Code. (ie. HRAI Digest 1980, Manual J 6th. ed.)
7. The re-installation of the existing central A/C system.

The submitted quotation should indicate the installation date, the down time of the oil furnace when no heat would be available, the payment terms, and the guarantee.

RETROFIT SPECIFICATION SHEET

Brampton (14)

High Efficiency Hydro Pulse Boiler

- with exhaust muffler
- installed
- including condensate pump (if required)
- sized in accordance with a heat loss calculation

The installation and cost of installation shall include:

(1) The complete installation of the above unit, by a certified gas fitter.

(2) The removal of the present oil-fired boiler, two oil tanks, and flue.

(3) The closing off of the bottom chimney opening where the flue entered.

(4) The sealing of the oil-fill pipe to avoid accidental oil filling.

(5) The appropriate arrangements with Consumer's Gas, to ensure that a gas line is run into the house at a time that coincides with furnace installation.

(6) The supply of, and completion of, all forms required to obtain a COSP Grant.

(7) Obtaining of a building permit and related inspection.

(8) The boiler down time should be minimized.

(9) Installation should be ASAP.

APPENDIX

House # 1

Oil consumption from Oct 17/83 to Feb. 27/84

446
450
500
423
453
371
389

3032 Total lit = 32836.56 kW

Heating degree day

7.8
8.8
13.4
13.7
13.6
12.7
10.2
12.3
11.6
11.8
14.3
6.2
16.6
16.4
440.7
756.6
858.9
511.1

2736.7 Total applicable degree days

kW/degree day after tune-up = 11.99859

kW/degree day before tune-up = 11.82

Change in fuel consumption = 1.02%

House # 2

Oil consumption from July 1/83 to Feb. 23/84

292
439
459
515

1705 Total litres = 18465.15 kW

Heating degree days

2949.6

kW/degree day = 6.26 After Tune-up

kW/degree day = 7.65 Before tune-up

Change in fuel consumption resulting from tune-up = -18.11%

House # 3

Oil consumption from No. 29/83 to feb. 10/84

675
636
728

2039 Total litres = 22082.37 kW

Heating degree days

20.2
756.1
858.9

29
23.6
24.2
34.5
29.5
32.5
27.8
25.5
28.3

1890.1 Total applicable degree days

kW/degree day = 11.68317

This house has a hybrid oil/heatpump system

HOUSE 4

Electrical consumption for heating from Sept/19/83 to Feb.15/84

940
1890
3670
2360

8860 kW

Heating degree days

2766.4

kW/degree day = 2.20 after tune-up

kW/degree day = 3.5 before tune-up

Change in energy consumption resulting from tune-up = -37.07%

HOUSE 5

No determination of energy consumption changes can be made for this house because of the failure of the gas meter during the total 1983/1984 heating season.

The meter failure also explains why we had unusual results during Phase 1 monitoring.

HOUSE 6

Electrical consumption for space heating from Oct. 18/83 to May 16/84 = 18474 kW

Applicable degree days = 4057.2

kW/degree day = 4.54 after tune-up

kW/degree day = 5.4 before tune-up

Reduction in energy consumption since tune-up = -15.93%

HOUSE 7

kW/degree day befor tune-up = 7.14

Gas consumed between Oct. 4/83 and Feb. 6/83 =

1836 M3 Less 160 M3 used for hot water = 1676 M3 =

17347 kW.

Applicable degree days = 2426.7

kW/degree day after tune-up = 7.18

Change in gas consumption since tune-up = 0.60%

Owner previously used a wood stove for supplementary heat; however, because of a large crack in the top of the stove, the stove was seldom used during the 1983/1984 heating season.

HOUSE 8

Gas consumption for heating between Oct. 4/83 and Feb. 6/83 =

1606 Cubic meters = 16622.1 kW

Applicable degree days =

2470.4

kW/degree day = 6.73 after tune-up

kW/degree day = 9.23 before tune-up

Change in gas consumption resulting from tune-up = -27.10%

HOUSE 9

Oil consumption between March 22/83 and Jan. 14/84 =

1375 L = 14891 kW

Applicable degree days = 2797.8

kW/degree day = 5.32 after tune-up

kW/degree day = 6.1 before tune-up

Reduction in oil consumption since the tune-up = -12.79%

HOUSE 10

Electrical consumption for heating from Sept/83 to Feb/84

210
250
1580
1870
3670
2600

10180 kW

Heating degree days

3003.7

kW/degree day = 3.39 after tune-up

kW/degree day = 5.58 before tune-up

Change in energy consumtion resulting from tune-up = -39.26%

HOUSE 11

Gas consumption for heating between Oct. 26/83 and Dec. 29/83

1477.5 Cubic meters = 15292.12 kW

Heating degree days

82.4

285.1
440.7
693.1

1501.3

kW/degree day = 10.19 after tune-up

kW/degree day = 13.43 before tune-up

Change in gas consumption resulting from tune-up = -24.16%

HOUSE 12

Gas consumption between Oct. 4/83 and Feb. 6/84

2667.5 cubic meters less 445.2 used for hot water =

2222.3 cubic meters = 23001 kW

Applicable degree days = 2470

kW/degree day = 9.31 after tune-up

kW/degree day = 7.52 before tune-up

Changes in consumption since tune-up = 23.80%

New owners since tune-up may influence results.

HOUSE 13

Gas consumption for heating between Oct. 4/83 and April 3/84 =

1755 M3 = 18164.3 kW

Applicable degree days = 3641.2

kW/degree day = 5 after tune-up

Average kW/degree day before tune-up = 7.19

Reduction in gas consumption since tune-up = -30.46%

HOUSE 14

Oil consumption between Jan. 2/84 and Feb. 23/84

169 litres = 1791.4 kW

Applicable heating degree days

814.6
427.4

1242

kW/degree day = 1.44 after tune-up

Electric consumption for space heating from Oct. 18/83 to Feb. 14/84

4340 kW

Applicable heating degree days

175.6
440.7
756.1
858.9
294

2525.3

kW/degree day = 1.72 after tune-up

Total kW/degree days after tune-up = 3.16

kW/degree day before tune-up = 5.18

A heat pump has been added to the oil furnace since the tune-up.

Savings resulting from tune-up and heat pump = -38.98%

HOUSE 15

Oil consumption between Dec. 24/83 and Mar. 13/84

1760 litres = 19060.8 kW

Applicable degree days = 2968

kW/degree day = 6.42 after tune-up

kW/degree day = 8.62 before tune-up (corrected from phase 1 report)

Savings resulting from tune-up = -25.52%

HOUSE 16

Oil consumption between Sept. 21/83 and April 5/84 =

2625 L = 28428.8 kW

Applicable degree days = 3718.3

kW/degree day = 7.65 after tune-up.

kW/degree day = 9.42 before tune-up.

Change in oil consumption since tune-up = -18.79%

HOUSE # 17

Oil Consumption from Oct. 17/83 to Jan. 20/84

347
440
489

1276 Total Litres = 13819.08

Heating Degree Days

7.8
8.8
13.4
13.7
13.6
12.7
10.2
12.3
11.6
11.8
14.3
6.2
16.6
16.4
14
440.7
756.1
23.3
21
19.5
17.7
17.5
22.1
31.8
26.5
30.8
29.5
35.5
35.2
26.1
30.2
39.4
36.5
26.8
29.?
34.3
34.9

1948.1

kW/degree day = 7.09 After tune-up

kW/degree day = 7.71 Before tune-up

Change in fuel consumption resulting from tune-up = -8.04%

HOUSE 18

Oil consumption for heating between Oct. 27/83 and March 27/84 =

3221 L = 34883 kW

Applicable degree days = 3250.2

kW/degree day = 10.73 after tune-up.

kw/degree day = 16.15 before tune-up.

Reduction in oil consumption resulting from tune-up = -33.56%

HOUSE 19

Oil consumption for heating between Nov. 15/83 and March 12/84 =

1385 litres =14999.55 kW

Applicable heating degree days =

2768.3

kW/degree day = 5.42 after tune-up

kW/degree day = 5.66 before tune-up

Change in oil consumption resulting from tune-up = -4.27%

HOUSE 20

Gas consumption between Sept. 6/83 and Feb. 6/84

1666 cubic meters

Gas used for space heating `1666 -125 for hot water= 1541 = 15949.35 kW

Applicable degree days = 2558

kW/degree day = 6.24 after tune-up

kW/degree day = 11.7 before tune-up with oil furnace.

Reduction in heat required resulting from change to gas heating -46.71%

POOR

QUALITY

ORIGINAL